# Crossing the Chasm: The Technology Adoption Model as a Guide to Innovation in Australian Biotechnology Companies

**Dr. Boaz Bernstein**
**Queensland University of Technology**
**Email: b.bernstein@qut.edu.au**

**Dr. Prakash Singh**
**University of Melbourne**
**pjsingh@unimelb.edu.au**

**Dr. Kavoos Mohannak**
**Queensland University of Technology**
**Email: k.mohannak@qut.edu.au**

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## Abstract:

This article presents a framework that explains the process of innovation and how it evolves over time, based on the practices of ten biotechnology companies in Australia. The proposed conceptual model is synthesised for the first time with the technology adoption life cycle model. We introduce four constructs that are linked to the innovation process and play important roles in achieving successful innovation outcomes. Our observations are different from other models described in the literature of the innovation process. We present a more complex set of factors which seem to facilitate new communication paths in transferring knowledge from one stage of the innovation process to another. These paths influence the transition of ideas from the early design stage to implementation, thus facilitating movement across an innovation chasm inside organizations. Results of this study improve our understanding of the innovation process by building a more comprehensive and accurate framework based on case study research method.

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## INTRODUCTION

Being innovative has become one of the most important factors for organizations in sustaining their competitiveness. This has been widely recognized by scholars studying the field, yet the vast and diverse research in this area is still fragmented and inconsistent (Wolfe 1994; Edwards 2000; Kanter 2001). Recent studies have called for a more integrated approach to better understand the interaction between internal organization activities, sequence in the innovation process and managerial constructs affecting the ability of companies to innovate. There appears to be broad agreement that a combination of these factors is instrumental to better understanding the innovation process from a holistic perspective.

This study provides new evidence from the Australian biotechnology industry which supports the recent body of innovation literature asserting that innovation is not a singular and isolated event, but a series of activities which interact in a complex way towards achieving innovation success. Determining the path by which innovation can successfully move inside the organization and achieve wide acceptance and implementation is an important process in securing long term competitiveness in today's turbulent markets. This paper also attempts, for the first time, to synthesis the well published technology adoption life cycle model by Geoffrey Moore (1991) with the innovation process to establish a conceptual integrated model of innovation in organizations.

We first examine the wide body of literature in the field in order to construct a framework for placing the key theories leading to a more holistic approach to studying innovation. The innovation literature is vast and highly fragmented. It draws from multiple disciplines of knowledge, social sciences, economics, psychology and management. As this paper attempts to synthesis previous work in the field, an historic approach was adopted, reflecting the sequence of events in innovation theory development over the past half century.

The second objective of this article is to explore how the Moore principles can be used to provide a new framework to better understanding the dynamics and complexity of the innovation process in organizations. We develop case study observations about the innovation process in ten biotechnology companies across Australia. We then identify four constructs (management, communication, structure, control) which seem important in determining successful innovation outcomes. A conceptual model is developed to show how these constructs influence the progression of innovation from the initial stage of idea generation to innovation implementation, and ways in which companies can achieve successful transition over the innovation chasm.

The next section of this article provides a review of the existing literature on innovation process. This is followed by the description of the methodology used to develop the conceptual model for explaining the innovation process in organizations. Next, we examine the four constructs and link them to different stages in the innovation process. We also demonstrate how each of the constructs may facilitate a smooth transition over the innovation chasm. Finally, we provide suggestions for including these constructs as important dimensions in future studies.

## LITERATURE REVIEW

Research studies of innovation have come a long way since the early work of Schumpeter (1934) where he placed innovation in the centre of his theory of economic development. Many scholars since then have attempted to

define innovation and its impact on sustaining organizations' competitiveness (Edwards, 2000; Damanpour, 1991; Harrisson & Laberge,2002; Kanter, 2001). Though the vast and diverse research in the area has provided meaningful concepts to understanding the determinants of innovation and success in organizations, these views are nevertheless limited in their own view. There is still a lack of consistency in the literature making it difficult for the reader to draw meaningful conclusions or practical applications.

The prevalence of different approaches in studying innovation in organizations is therefore well grounded, and the need for a more 'panoramic' view has been suggested (Rothwell, 1994). Our research attempts to build on the integrative approach to studying innovation and add to it new explanatory constructs which have proved to be highly relevant in explaining the innovation process in the Australian biotechnology industry.

***Early studies***

The early studies of the innovation process, mostly in the 1950s and 1960s usually proposed a simple unitary progression of phases or stages in the development of products. These models were presented as simple linear sequential events focused on Research and Development (R&D). In their excellent review of managing innovation and change process, Schroeder, et al. (1986) provide a chronological summary of the innovation process and conclude that early developments of the innovation model are inadequate in dealing with the complexities in managing the innovation process. They also call for a re-examination of these previous studies implementing a more dynamic approach with more rigorous empirical evidence. Many of these early studies also assumed that individuals are the major source of change in organizations. Rogers (1962) and Schon (1963) have identified the main determinants of innovation in terms of age, educational level, gender, cognitive style, and creativity. Under the individualist perspective, the focus is on the action of individuals. Individuals in organizations are regarded as supreme agents acquiring outstanding qualities such as skills, knowledge and power, among others. They are regarded as playing the leading roles of facilitating innovations in organizations. Edwards (2000) states that these actions from individuals are not believed to be constrained by external factors; rather they are believed to be the outcome of self-directing agents who are capable of introducing change in organizations.

These results suggest that informal structures in an organization may be more critical than formal structures when the exercise of power requires extensive boundary, and where sources of power have both general and innovation specific effects. This may not come as a surprise as informal organizational networks are a powerful mechanism for the control and distribution of a wide array of resources and play a critical role in the innovation processes in organizations. Nevertheless, whether innovation is stimulated by the individual, technology, R&D, or the markets misses the point. These studies modulate the deterministic variables driving the idea process but fail to explain how this process occurs in an organization. They also fail to shed light on the complexity of the process aligning together structure and knowledge of the individual agent in a functional process of value creation. Perhaps the most significant shortfall of these studies is their inability to provide real-time observations and follow the innovation process in its different stages as events occur. This identifies a need for applying a more realistic approach to studying innovation which includes multiple, cumulative, progressional, and perhaps longitudinal research methods. The next body of literature provides some more evidence toward an interactive model linking together markets and technology as well as organization structures and people.

***Organizational approach***

The organizational approach evolved in the 1970s as a new dimension in innovation research. It was developed to address the deficiencies of explaining innovation as an outcome of individual behaviour. Research evolved around the structural parameters of organizations and the importance of organizational functionality within the business environment. This view of innovation focused on both structural functionalism and contingency theory, with an attempt toward explaining how organizational structure constrains or propels the innovation process. It also shows the role of functional departments in the organization and ways in converting information into ideas, utilizing knowledge towards product development and delivery of products into the market place. For example, models by Rotwell and Zegveld (1985) show the innovation process as a sequence of events linked to organizational functionality where each function hold a distinctive role in the contribution of innovation success. In a later study, Rothwell (1994) emphasizes that during this period of relative prosperity there was corporate emphasis on growth, both organic and acquired, and a growing level of corporate diversification.

The focus in other studies (Johnson, 2001; Edwards, 2000; Meyer, 2001; O'Connor, 2001) also shifted from individual levels towards studying market trends and shifting the concentration to demand side factors. Factors like trends in new products and expansionary technological change were introduced. This view has placed the market as the source of ideas for directing R&D, which had an interactive role in the innovation process. The intensifying competition accompanied by growing strategic emphasis on marketing thus result in the interaction of organizational structures and market-pull variables. Other studies (Nambisan, 2002; Kodama, 2001; Leifer, 2001) found that in mature and ongoing organizations, attempts to modify the products or markets are constrained by the organization's existing manufacturing and management competencies. As innovation in organizations begun to shift towards market demand, issues concerning the alignment of organizational structure to its environment became a major topic in research.

Other researchers were inspired to incorporate issues of centralization, complexity, formalization, size, strategy, and organization goals as some of the main characteristics influencing innovation. Yet, a controversial discussion was created as to the significance of these variables as predictors of innovation, and contradictory results were found among structural variables such as centralization, complexity, and formalization. As a remedy, Zaltman (1973) developed a contingency theory that predicts the effect of structural variables is contingent upon innovation initiation and innovation implementation, thus providing a link between the different stages of innovation and structural variables necessary to accommodate the process.

***Integrated approach***

The third body of literature is constructed under the integrated approach reflecting the synthesis of individual behaviour parameters as well as structural variables in the organization. The innovation process is looked upon as a complex stream of communication linking the structural features of the organization to knowledge creation. Knowledge is transferred from R&D through manufacturing, marketing and service through internal linkages, and moves inside and outside the organization through external linkages. Initiation of the innovation process is thus dependent on three main sources: organization capabilities, science and technology developments, and the marketplace. The genuine works to trigger this new body of literature are Van de Ven and Rogers (1988), and Pettigrew (1985). Under the notion of an integrated approach, innovation is not to be seen as the result of freely participating individuals (individual approach) nor is it believed to be dependent on some objective characteristic of

the organization (organizational approach) Rather, it reflects the continuity or modification of those rules and resources that mediate and are an outcome of human conduct in an organizational setting.

A discussion on the integrated view provided by Rothwell (1994) suggests a common sequence in the process of innovation. Though not necessarily a continuous process that can be divided into a series of functionally distinct entities, but that of interacting and interdependent stages. The overall pattern of the innovation process can be thought of as a complex net of communication paths, both intra-organisational and extra-organisational, linking together the various in-house functions and linking the firm to the broader scientific and technological community and the marketplace. The description highlights the importance of feedback emphasizing the significance placed in communication where it links the internal functions of a firm to the external knowledge pool.

We developed our research study bearing in mind Rothwell's findings and the more recent studies on system approach to the innovation process (Edward 200; Kanter 2001; Read 2000). We were particularly interested in determining a path by which a firm can navigate its idea from the design stage through to implementation. The next section describes our methodology and research observations.

## METHODOLOGY AND RESEARCH OBSERVATIONS

In order to avoid some of the problems discussed in the literature review, the grounded theory (Glaser and Strauss, 1967) approach was adopted. We hoped to develop a model by examining the data that was collected. Hence, we searched for activities and information related to the innovation process.

Data collection was based on interviews with executive managers from ten biotechnology companies around Australia. The information used in the study was obtained by interviewing senior managers in these organizations. The interviewees were mostly general mangers of the companies or the heads of R&D programs. The interviews, lasting between one to two hours, were semi-structured. Interviewees were provided with a set of a priori questions which helped them prepare for the interviews. Most of the information collected pertained to events in the innovation process of each company. Observations included management aspects of people, groups, as well as organizational constructs in the innovation process. Table 1. summarizes the evidence observed across the ten companies which will be discussed in detail below.

Table 1, about here

We identified four stages in the innovation process, namely idea generation, innovation support, innovation development, and product launch. These four stages were regularly repeated by our interviewees as the most important milestones in the success of their product innovation process. These stages are also consistent with the stage model literature (Rogers, 1983; Cooper and Zmud, 1990, Scott, 1994). Idea generation is identified as the initial stage in the design process where individuals in the organization gather information from both internal as well as external sources. Innovation support was the second step in the process where ideas are introduced to the management level and evaluated against company goals. Many ideas are lost at this stage due to the low level of support provided by the organization. However, the ideas that do make it through are set up as projects with clear development methods and project specifications. We have also identified idea generation and idea support being as part of innovation design.

The creation of new knowledge is considered by many as the main drivers of innovation (Nonaka and Takeuchi 1995). Generating ideas and adopting new knowledge requires forward thinking that challenges perceived structures and common procedures in the organization. Innovation development and product launce were identified as being part of innovation implementation. Once an idea takes shape, it is supported by the organization and moves in the process to being pursued and finally launched to the marketplace. This stage of implementation involves transforming the idea to market realization. It is largely an effort to solve technological problems, and marketing problems involved in launching the product to market. This stage of development is often identified with a formalized project structure supported by the organization with adequate finance and other resources provided. The last stage of product launch represents the introduction of the 'fruits of innovation' into the marketplace. Marketing functions often take the leading role in this stage aligning the product with market expectations, and feeding back market information for future improvements.

Table 1 introduces four organizational constructs that were identified as important in facilitating successful innovation outcome (management, communications, structure, and control). We also found that each of these constructs plays a different role, depending on progression in the different stages of the innovation process. In the next section we will discuss how each construct is linked to the innovation process. We will also provide evidence as to the contribution of each construct in making a smooth transition between the different stages in the process.

### *Management and innovation design*

Management support is not a new construct in facilitating the innovation process. Research findings can be found in Rothwell (1994), Rogers (1983), and Edwards (2000). Yet, our research shows that management activities may require a different managerial approach across different stages of the innovation process. For example, encouraging participation is important in the first stage of the process. Often employees do not have the initiative to engage in innovation thinking. This needs to be well communicated by managers, thus providing clear goals and a sense of direction, particularly in more mature companies where each employee has defined responsibility. Several companies have taken a more proactive approach to encourage idea generation. A general manager of a diagnostic company has expressed his views as follows:

> *"We are a small team and everyone is expected to be innovative. We have management meetings weekly, and we have a monthly team meeting where everybody comes in, where we will have Pizza and occasionally we will have Champagne. That helps with the brainstorming."*

The same manger has also found a way to encourage innovation efforts by one of his employees:

> *" That was a really good idea if you translate that to how much it would save in labour……..He got two movie tickets for that. People come up with ideas like that. They get spot rewards and are encouraged to come up with more. And he felt really good. We get lots of ideas this way… they come up with little things that can make the difference to the business".*

The importance of rewarding new ideas was expressed by another manager:

> *"You have to reward success. We celebrate success a lot more than we had in the past. When I was running the company before the new guy came along, every Friday we went to a place for afternoon mealtime, where we sit around and chat. So we do try to encourage social direction. When the news came and there is a mistake, we will go back to the product with a beer."*

These findings are also consistent with research done by Scott and Bruce (1994). In their study of determinants of innovation behaviour they showed a positive correlation between innovation behaviour and quality of

the supervisor-subordinate relationship. They have also found that high levels of managerial support, trust and autonomy are fundamental in supporting the innovation process in its early stages.

Managers pointed out the importance of setting project criteria and methods in the innovation support stage. It was also important to involve other functions across the organization. At times, the scientific ideas were found to be brilliant, however, with little market applicability. Cross functional teams were helpful in writing clear product requirements for the next development phase. Successful outcomes need a mix of good technical viability as well as matching customer needs. One of the R&D executives commenting on cross-functional teams:

> *"We sit down and have a brainstorming session. We describe what we need to do to get a product on the market. What the benchmarks of our competitors from a marketing perspective that needs to be achieved. So we go back down to where we are now and evaluate the situation. What are the problems to be resolved and where we fall short on this aspect. Then we determine the best person in the room with the best scope or knowledge to tackle the ideas"*

We further found that even if innovators in the organization had the access to the required technical and market information, there was still a need to initiate support systems. These systems, in early stages of the process, were important in facilitating the integration of knowledge in converting good ideas into successful products. These social parameters are beyond "creating the right environment in the organization" nor a supportive innovation leadership. Some future questions may be in the form of: Is the organization providing enough freedom for its employees to engage in creative thinking rather than following management guidelines? Do organizations provide enough risk leverage for their innovators to think "out of the box"? How are innovation failures dealt with by mangers in the organization? Are there sufficient rewards for successful adoptions? And, at what level do we measure innovation success: individual, organizational, or industry?

### *Communication and innovation design*

The importance placed on communication inside and outside the organization was reiterated by our interviewees. There are several key communication links in the organization that need to exist in order for the innovation process to be successful. Indeed, the importance of both formal and informal communication links is well documented in the literature. For example, Nonaka and Kenney (1991), describe innovation as an information creation process that arises out of social interaction. They also point out the importance of organizational structure as a host within which the creative process is located. Our observations indicate that communication during the first stage of idea creation sets the direction for the remaining development process. Especially engaging, are team interactions which provide an opportunity for new thoughts and potential new ideas to be shared. Managers have an important role in providing an accommodating environment for these interactions to take place. As expressed by one of our interviewees:

> "*So we get lots of ideas from people in the team and we constantly say that go and talk to all your friends and ask them what they think…..we are open to all those ideas and as they come back we make more modifications. In fact most of the interaction doesn't happen inside meetings, a lot of it happens in the hallways. And people need to feel at ease with each other. People need to talk about things, about issues. In fact a lot of stuff which is said in the hall way often gets done (in projects)."*

In the early stages of innovation communication links between the person generating the idea and his manager are important in seeking the support and securing organization resources for future development of the idea. We have also found that bringing people from different disciplines in the organization may foster creativity in the idea generation stage. People from different functions have different views and perspectives and thus helping to generate new ideas. In the development stage, communication links between the project development team and other organization functions becomes important. Information from different sources needs to come together in order to

achieve a viable product design. As reflected by one of the general mangers overlooking an unsuccessful design program:

> *"I think the real complaint among the engineers is the communication. It was not effective. And they didn't know what the overall project was doing. It was all a bit unfair, because they didn't now. They never got into details of what is going on with the other groups."*

Although many of the biotechnology companies are blessed with internal technical information, many of the new ideas originate from ad hoc laboratory experimentations involving cross sectional teams. There is also a growing importance of tacit knowledge which evolves without any theoretical modelling. Such knowledge can keep developing through practice and experimentation. Although gaining access to internal knowledge is important, an equal aspect in importance was gaining knowledge through external communication. Trying to assess customer preference and what the market really needs. As one of the managing directors of a diagnostic company pointed out:

> *"I spend most of the time going out and talking to surgeons. Sneaking up to find out our competitors with a camera and take pictures of their stuff. I am the one who brings back market information, trying to figure out what clients really want out there. That's largely my role now, to make sure what the products are like out there and to find out what the market wants."*

As the innovation process evolves from idea generation to innovation support the importance of formal communication is highlighted. The need to communicate the idea across the organization becomes increasingly important as different functions of the organization are likely to be involved in its future development. For example, an idea coming from the research department should be shared internally with both the manufacturing department to provide for production inputs and manufacturing line schedules as well as the marketing department for market needs assessment and distribution of resources. These important communication measures have been found to be important in setting the stage for the implementation stage. The idea generators would need to find people in the organization that are willing to accept their idea or project and transform it to a more tangible program.

## Structure and innovation implementation

Organization structure has an important effect on the innovation process as it determines the link between employees and their activities. It also defines the lines of responsibilities in the organization for managing business functions, project units, and specific activities. It was interesting to learn from our data that structure had a relatively small impact in the early stages of the innovation process compared to the later stages of development and implementation. It was more important for mangers to keep a relatively flat hierarchy around individuals to support idea generation. It also seemed to have a lesser impact on the early stages of the innovation process compared to the two constructs identified with the design stage. As innovation progresses to development phase the structure assumes a more central role. Managers have stressed the need to provide project teams with a greater level of independency, particularly in controlling their resources. It was also sought acceptable to integrate innovation teams to ongoing operations in the organization during the implementation stage. There is often a need to recruit new expertise to the team and secure financial resources for development tools and product material. A complex line of report may cause inefficiencies and prolong the development period.

We also found that the formalization of the innovation team in gaining a project status has an impact on achieving success. The recognition awarded by the organization management team is a positive contribution to the members of the team involved in the process. Lack of formal project status may reduce the commitment of employees to engage in the final stages of development and may stall the launch of product to market. The next possible step is the integration of the project team as part of ongoing company operations. This may provide more resources to

develop the next generation of innovation and a positive signal for team members as they are recognised for their contribution.

## Control and innovation implementation

The use of control mechanisms in organizations often adheres to the large body of strategic management literature. This body of literature refers to strategic control systems as a strategic monitoring tool to assess how well an organization is performing or about how well the firm is using its current resources (Mintzberg 1979; Simmons, 1994; Flamholtz, 1979). It is also about how organizations reward their employees to keep them motivated and encourage them to focus on solving problems. However, very few studies have focused on how control systems link to the innovation process. Our observations go beyond controlling the four basic building block of competitive advantage to obtain superior efficiency, quality, innovation, and responsiveness to customers. We have found that control has a significant role in the implementation stages of the innovation process. Top managers in many of our cases have placed considerable effort to controlling the innovation process by: 1) assessing innovation goals early in the development stage and their alignment with more general organization goals; 2) setting a formal structure for an innovation team with clear progression milestones; 3) setting performance measures in the development stage to filter good innovation projects from the lemons; 4) setting feedback mechanisms to gain information from internal sources as well as from customers and the external community.

An interesting observation came from a leading diagnostic company. The company has separated their research activities from development in order to provide greater focus for the idea generation process. We were also informed of a more structured process and clear guidelines were set for its innovation development stage. This was found necessary as unprofitable projects found their way through the innovation process to finally realize that they do not meet the technical criteria or are not commercially viable. As noted by the head of research:

> *"It's hard to start a project, but more difficult to stop it. We're not a rich company, projects that run for two or three years without profit are simply not going to make it. The whole idea now is to stop projects much earlier, thirty percent of the products fail because many are making what the customer doesn't want. Even the development people have seen the technical failures and come up with a product that really doesn't do much. This happens because they are not constantly checking if it's on track with where we are doing. Often it becomes a drain on effort, time and resources".*

Financial control in the implementation stage was found as a common mechanism in many companies to facilitate the innovation process into its product launch phase. It was also a common procedure to stop unsuccessful innovation ideas before they drain resources. The most common control mechanism among the companies we reviewed was the milestone base review. Each project was identified with several milestones and reviewed against outcomes. These outcomes have an important impact on the future feasibility of the project in terms of being technically sound and could sell in the market. Project s that successfully meet the milestone requirements are provided with additional funding for the next development stage. If on the other hand, it does not meet these requirements it may either be provided with an extension to meet the next milestone gate or be terminated. On the importance of milestone control we received the following comment from a management team:

> *"Each project has defined milestones. I guess one way to do it is to just simply approve funding of a project/product to a certain milestone, and then see it progress, and see if it has past the test. But at the same time, we strongly identify what is required for the next stage before approving funding. We identify what the next step needs to achieve, so everyone is very clear, down to the details. Very detailed requirements of what is needed to be achieved."*

Thus, we observed a set of well defined criteria utilized by managers in different stages of the innovation process. There seems to be a fine balance between the provision of a relative flexible systems to encourage ideas in the

initial stages to a more rigid and defined controlled structure in the development stages. There also seems to be a considerable sensitivity to assessing market needs and the commercial potential of products in the marketplace before resources are committed to development.

## A NEW FRAMEWORK FOR INNOVATION

We have described a general process of innovation as reflected from data collected from ten interviews in the biotechnology industry. We defined four stages in the innovation process which are identified with the design stage in the early phases and implementation later in the process. In meeting the second objective of this study we developed a conceptual innovation process model illustrated in Figure 1.

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Figure 1. About here

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This paper attempts, for the first time, to synthesis the innovation process with the technology adoption life cycle model published by Geoffrey Moore (1991). We also demonstrate the similarities of Moore's model to the innovation process, and discuss how the fundamental concepts of crossing the chasm can be used in explaining a smooth transition from early innovation design to successful implementation.

According to the lower part of Figure 1, the first two groups are the innovators and early adopters, and together they form the early market. The early market consists of open minded individuals who are willing to take risk and break from the pack. The life cycle theory suggests that once the early market has accepted the discontinuous innovation late adopters will follow. In contrast to those customers making up the early market, the late adopters tend to be conformist, more rigid to changing consumer behaviour and stay with the herd. Moore emphasises the importance of crossing the chasm as a fundamental imperative in organization success. As innovative products are introduced to the market they will initially be accepted by technology enthusiastic consumers which are receptive to new product developments and are willing to experience new features. During this period sales will often decline as these consumers represent only a small fraction of market share. If the product can successfully cross the chasm, it will gain market acceptance with the main stream market and sales will achieve accelerating growth rates. Moore further hypothesised that once a larger market share is captured in the mainstream market, product performance can be improved and cost economies can be achieved to improve market competition.

The way to cross the chasm according to Moore is to establish a small group of niche consumers in the mainstream market where customer needs provide for a good match with technology attributes. Once this group has accepted the new technology it is much easier to move to the next consumer groups in the mainstream and convince them to follow. Some companies will not be able to make this transition. Organizations that fail to cross the chasm and build relationships with the mainstream market are destined to run out of early adopters and seize to exist.

In attempting to synthesis the technology lifecycle theory and the innovation process inside organizations, the S-curve model was adopted. It offers an explanation of organizational growth over time. The S-curve is derived from evolutionary biology, but it has universal applications in business and marketing literature. It describes a process which starts slowly, then gradually gathering pace and moving into fast pace of growth, then when growth slows down due to saturation it finally reaches plateau and subsides. The s-curve model has been widely used and covers universal applications for product lifecycle, services, process, systems structures and business models (Smallwood 1973). We thus adopt the s-curve model to demonstrate the evolvement of the innovation process.

The innovation process begins with a starting phase of experimentation while the idea is generated. Employees often derive information from both internal sources within the organization or from external sources. Idea generators will often interact with other scientists in the field, university sources, colleagues in their area of research, as well as competitors. Similarly, employees will often interact with customers, suppliers and competitors to gain market information for better understanding what customers want before products are launched to the market. The progressional process continues through support and development toward its implementation in the marketplace. Each stage is limited by an area along the s-curve to reveal the separation in case information does not flow properly in the innovation process. It has been shown in other studies (Zirger and Maidique, 1990) that without substantial effort by the organization to bridge these barriers, information critical to the formulation of products, their development and marketing may be lost.

We have also introduced four constructs that seem to be strongly involved in determining innovation success. Hence, it is useful to integrate these four constructs and link them to the different innovation stages towards developing a more coherent and complete innovation process model. Each of the projects described to us, originated with an idea. As the idea progresses in the organization it often seeks support to further pursue the idea. We have noticed the importance of setting innovation criteria early in the innovation process to achieve greater effectiveness as the project progresses. We have also found the importance of management in assuming cross company teams to gain wide spread involvement and pockets of acceptance across the organization.

Some ideas were successful, however, in making the transition over the innovation chasm. Those ideas to receive the blessing of decision makers, provided with proper resource commitment, and after a working team was selected, move to the next stage of development. The development stage is often affiliated with clear specifications, however, much of the developer's time is dedicated to problem solving. We have found that the problems are both technical in nature, mostly scientific in the biotechnology industry, and market oriented with commercialization problems that need to be dealt with. Finally, innovation evolves to its final stage of market launch. The structural construct was particularly important in facilitating the idea over the chasm. Giving an innovative initiative the formal project status can have an impact on successful development and market launch. Building a committed and focused team around the innovation provides the initiative that it may lack without it. The advantage of a well integrated team with formal control mechanisms lies in its ability to gain wide recognition in the organization and access to resources needed for product improvements and market launch.

The process model described in this section linking key organizational constructs to the evolvement of innovation through time is a rather unique approach. Although, our model is similar in nature to the stage process adopted by researchers in the 1970's and 1980's, this model goes further by adding management, communication, structure and control as important constructs. We then further demonstrate the relationship of each of these constructs in a simultaneous, yet separate consideration in the various stages of innovation. Our approach suggests that all four dimensions are relevant. They are also unique in the way they are related to the different stages in the innovation process. But, can not be separated as they relate to each other for any given innovation.

The proposed model is defined in a more narrow way, linking organizational constructs and their attributes to the innovation process. This may help future researchers in better describing the relationships between organizational variables and the implementation of innovation in a process model.

## Conclusion

This article presents a framework of how the process of innovation evolves and the main factors that need to be considered if innovation is to move successfully from the design stage to implementation. Using the data we collected from in-depth interviews with top management, we identified four main constructs that seem to play a pivotal role in the innovation process. All four factors are linked to each stage beginning with idea generation, then innovation support, innovation development and finally market launch. We provided evidence to show that each of these factors plays a different role in each of the process stages, thus resulting in a rather complex interaction of factors which are both internal and external to the organization.

Our proposed model is different from the more general sequential process models described in the literature and thus provides a more holistic approach to studying the innovation process. We observed a more complex set of factors which facilitate new communication paths in transferring knowledge from one stage of innovation to another. These paths are also influenced by internal linkages of the latest science and technology development in the biotechnology industry as well as external linkages from needs by consumers and the marketplace.

This study has also synthesised useful characteristics from the technology adoption life cycle model to improve our understanding of the innovation process. We were able to show a sequential evolvement of ideas in the organization similar to market adoption concepts presented by Moore. The idea of crossing market barriers was also adopted from the technology adoption life cycle model to explore how internal organization constructs may facilitate the smooth transition from the design stage of idea generation to successful implementation

Our study is qualitative in nature and lacks the general sable evidence often possible from studies using a larger database. Our findings are cross sectional in nature and therefore limit the ability to establish causality between constructs and variables. Future studies may apply a more longitudinal approach to explore the relationships introduced in this study and enhance their ability to explain innovation success. Finally, there is also a concern as to how generalizable our results across other industries. This study was limited to one specific industry, and therefore our results may not apply to other organizational settings. Nevertheless, parts of our findings were found to be similar with research done in other organizational and industry settings. It therefore may be useful to build on our findings for a more comprehensive understanding of how companies use their innovation process to gain successful outcomes.

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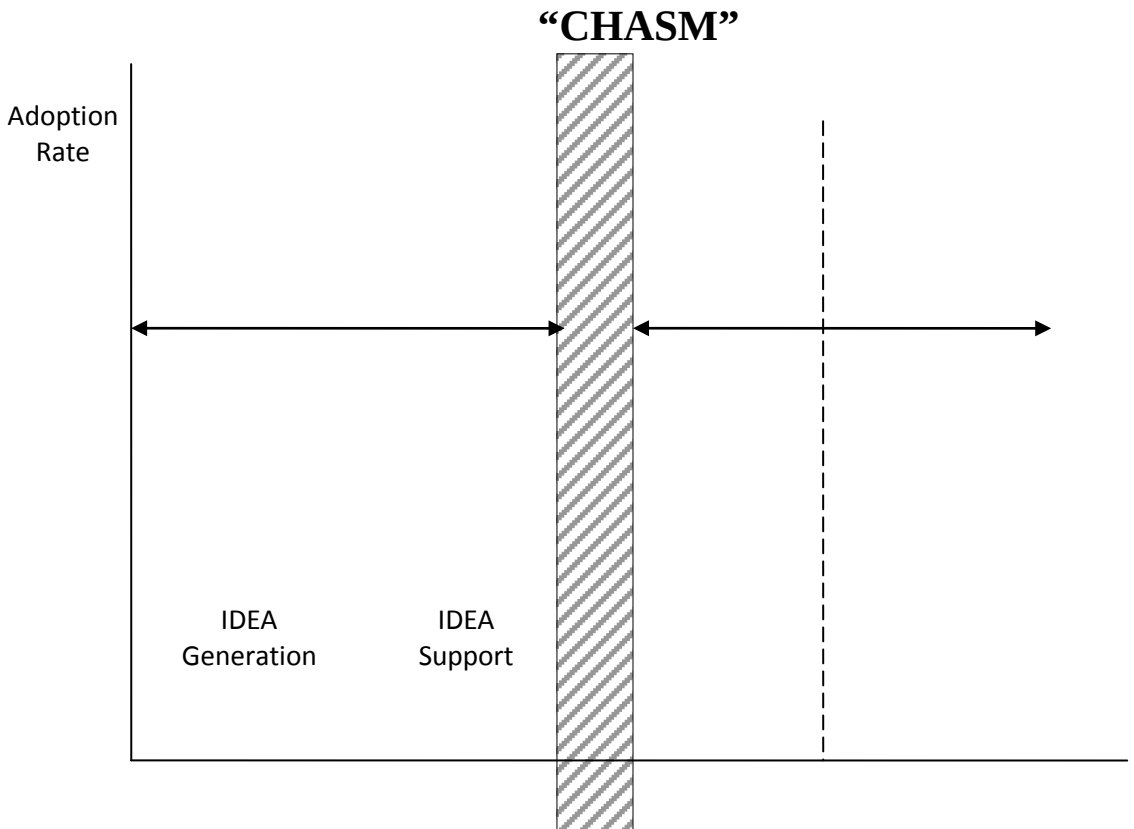
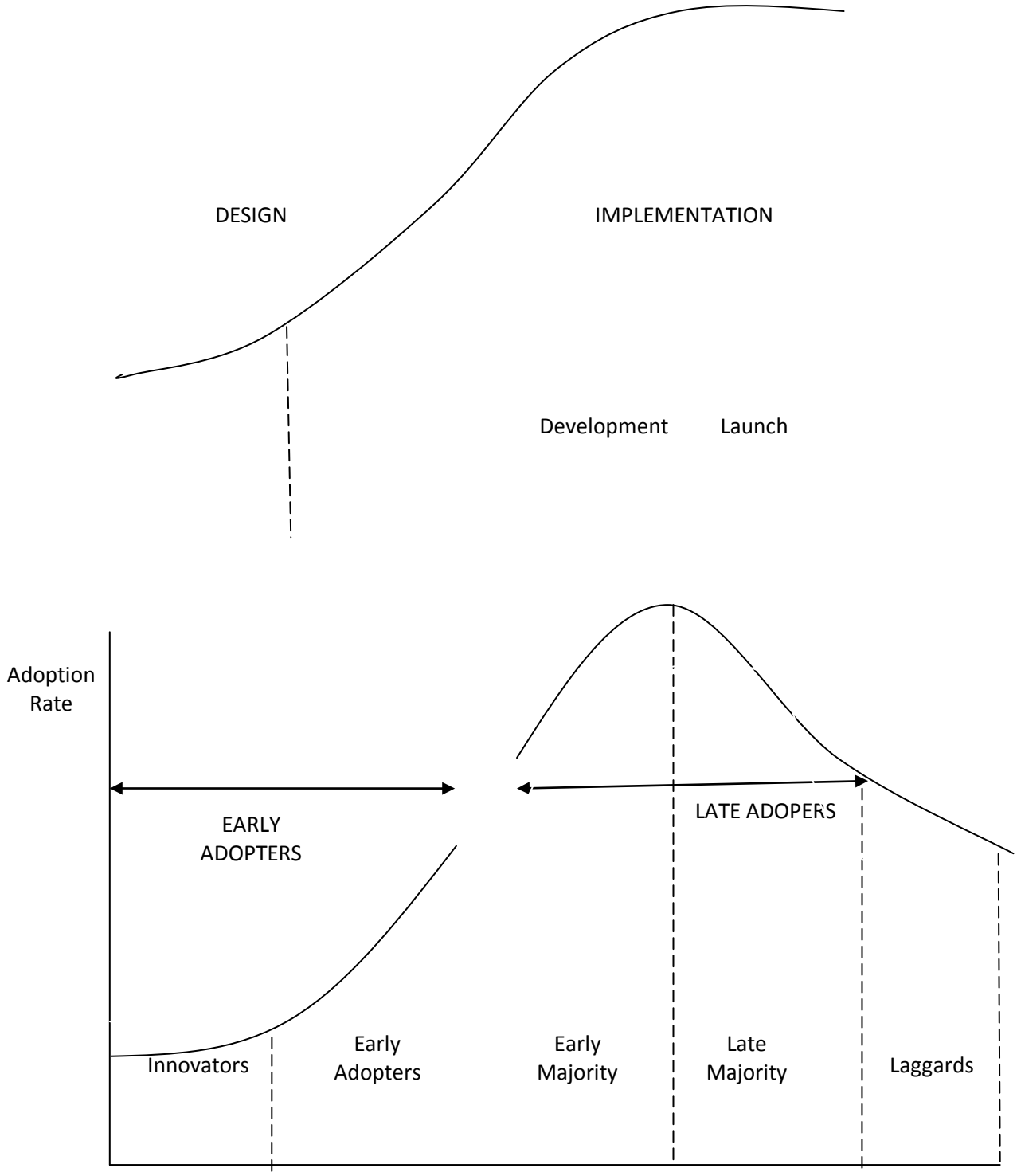
## Table 1. Innovation process observations

| | | MANAGEMENT | COMMUNICATION |
|---|---|---|---|
| DESIGN | IDEA | *encourage participation<br>*set individual/group goals<br>*provide incentive bonuses<br>*listen and accept new ideas | *external communication<br>*diverse idea team<br>*do not discourage failure<br>*importance of innovation goals |
| | SUPPORT | *set project methods and criteria<br>*cross company teams<br>*fit goals to new ideas<br>*provide close supervision | *cross-team communication<br>*positive evaluation support<br>*set evaluation criteria early<br>*encourage open discussion |
| IMPLEMENTATION | | **STRUCTURE** | **CONTROL** |
| | Development | *independent project team<br>*assess alternative structures<br>*link innovation to formal team<br>*innovation as part of ongoing operation<br>*easy reporting system | *performance measures<br>*project milestones<br>*financial control<br>*formal reporting scheme<br>*formal program with written procedures<br>*project team control its own resources |
| | Launch | *project team integrated into the organization<br>*independent business unit<br>*decentralized power<br>*Secure access to resources | *customer feedback and preference<br>*feedback loop for future innovation<br>*employee bonus scheme<br>*quality criteria control<br>*testing market requirements |

Figure 1. Conceptual Model for Crossing the innovation chasm






Source: G. Moore, 1991, “Crossing the Chasm” (New York: Harper Business).